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Synopsis

On

# " Study of Some Cosmological Models of the Universe within Fractal Gravity"

Submitted to

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**Doctor of Philosophy (Ph.D.)**

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Submitted by

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# Title: Study of Some Cosmological Models of the Universe within Fractal Gravity

## 1. Introduction:

Modern astrophysical observations in recent years have drawn attention to the fact that the current universe is not only expanding but also accelerating, as confirmed by cosmological experiments such as the measurement of type-Ia supernovae (SNeIa)[1-3], The cosmic microwave background(CMB )[4]-[5], large scale structure(LSS) [6] etc. To explain the universe's behaviour, a hypothetical form of energy known as dark energy is required. It was discovered that dark energy plays a significant role in the expansion of universe. However the actual mechanism behind this accelerating expansion of the universe is still a matter of debate. The matter in our universe is dominated by the dark energy (68%) and dark matter (26.8%). The remaining (4.5%) is occupied by the other ordinary matter. The problem of dark energy and dark matter is one of the difficult and indeterminate problems of modern cosmology. The dark energy is described by the equation of state (EoS) parameter $\omega = p/\rho$, where p and $\rho$ represents pressure of dark energy and density of dark energy. To explain the acceleration of the universe, the simplest candidate for dark energy is the cosmological constant, which represents the energy density associated with vacuum ($\omega = -1$). Many modified gravitational theories have evolved in order to provide a reasonable explanation for the issues of current cosmic acceleration. Some of these modified theories are Brans-Dicke theory [7], Saez-Ballester theory [8], f(R) theory [9], f(R, T) theory [10], where R is scalar curvature and T is the trace of energy momentum tensor, f(T) teleparallel theory [11], where T is Torsion scalar.

In the recent years Fractals are used to study the universe (galaxies, cluster, and super cluster of galaxies). Fractal gravity is one of the alternative theory of gravity to general relativity. The idea of fractals was presented and developed by Mandelbrot [12]. In the fractal cosmology standard cosmological principle is replaced by the conditional cosmological principle. According to this principle universe appears to be the same statistically in every galaxy and every direction. Fractal cosmology is the grouping of visible matter on large scale structure and the reason of the distribution of the universe. Initially, Luciano Pietronero attempted to model the distribution of galaxies using a fractal pattern in 1987. As the numbers of cataloged galaxies increased, a more detailed view of the universe’s large scale structure emerged over the following

decade. The universe exhibits a definite fractal aspect over a fairly broad scale range, with a fractal dimension of about 2. Fractal dimension allows us to assess the degree of complexity by observing how quickly our measurements increase or decrease as our scale increases or decreases.

## 2. Review of Literature and Development in the Subject:

The fractal cosmology was proposed by Calcagni [14-15], he proposed a model for power counting renormalizable field theory living in fractal space-time. The action in this theory is Lorentz invariant and equipped with Lebesgue-Stieltjes measure. In fractal cosmology time and space coordinates scale isotropically. A lot of remarkable work have been done in fractal cosmology. Dipanjana Das et al. [16] have examined the fractal cosmological model from the angle of recent observations. Hosseienkhani et al. [17] have studied the cosmological implications of ghost dark energy and generalized ghost dark energy models within the framework of fractal cosmology. The interacting dark energy models in fractal gravity have been investigated by Lemets and Yerokhin [18]. Karami et al. [19] have investigated holographic, new age graphic and ghost dark energy models in fractal cosmology. A. Najafi [20] have studied the anisotropic effect on scalar field ghost dark energy and the non-equilibrium thermodynamics in fractal cosmology. Rozgacheva and Agapov [21] constructed the fractal properties of the galaxy and qusar distribution. The extended versions of Ricci and holographic dark energy models in fractal cosmology was investigated by Mustafa et al. [22]. Recently Pawar et al. [23] have studied FRW model filled with domain walls in fractal cosmology. Aymen and Ali [24] have investigated behaviour of f(T) dark energy model in fractal framework. Maity and Debnath [25] have investigated the co-existence of different kinds of dark energy models such as tachyonic field, DBI-essence, hessence, k-essence, dilaton, quintessence with the modified Chaplygin gas (MCG) in fractal universe.

## 3. Aim and Objectives of Research:

We will work for a unified understanding of some cosmological models evolve during evolution of the universe using the Fractal theory of gravity. Considering all types of space-times including Bianchi types, Plane symmetric, Kantowski-Sachs FRW space -time and Kasner space-times, we will obtain the exact solutions of the Einstein's field equations, with perfect fluid, bulk viscous fluid, combinations of two- fluids, dark energy and dark matter, strings in fractal cosmology. Also we will be study some physical and geometrical parameters of the models.

## 4. Methodology:

Knowledge of the concern topic will be obtained by the survey of research papers, review articles, various books and journals. Also we would like to visit different research institutes like IIT's, TIFR, IUCAA Pune, BHU Varanasi, IISC, SGBA Uni. Amravati, RTM Uni. Nagpur etc to interact with eminent Mathematicians and Physicist also would like to attend national, international conference related to our research work.

## 5. Importance of Study:

Basic aim of our study is to determine the large-scale structure and evolution of the universe within the fractal framework. Another basic role of study is to obtain the required cosmological models in fractal cosmology and to investigate it by comparing with present day universe using astronomical data. Also we will be study the role of different fluids in the evolution of the universe. The present study will be useful for young researchers.

## 6. Plan of Research Work:

| **Sr. No.** | **Period** | **Plan of the work** | **Targets to be achieved** |
|---|---|---|---|
| 1 | First year | Study of the background required for the research topic. | Good command on the subject and clear the course work. |
| 2 | Second year | Collecting the papers and analyze them. | Try to get some Construction techniques. |
| 3 | Third Year | Work on some problems to be included in the thesis. | Submit at least two papers. |
| 4 | Fourth Year | Publishing some papers and submitting the Thesis. | Some more papers and Thesis submission. |

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